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Kitchen-related tasks used in occupational therapy during rehabilitation of adults with acquired brain injury: a systematic review

Short title

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Abstract

Introduction: Kitchen related tasks (KRTs) are widely used in occupational therapy (OT) for adults with acquired brain injury (ABI). This study aimed to investigate the effectiveness of KRT-based OT interventions for improving clinical and functional outcomes in the rehabilitation of adults with ABI.

Method: A systematic review of the literature was conducted with narrative synthesis (PROSPERO registration CRD42019141898), by searching relevant electronic databases (BNI, CINAHL Plus, MEDLINE, DORIS, OT Seeker etc.), registries of ongoing studies (ISRCTN, PROSPERO, etc.), and grey literature (OpenGrey, etc.). English-language studies that evaluated KRTs in the rehabilitation of adults with ABI were included and independently appraised for the methodological quality by two reviewers.

Results: Seventeen primary studies met the eligibility criteria. Studies were heterogeneous in methods, methodological quality, setting, sample size, purpose and design of KRTs. Fifteen studies evaluated KRT-based treatments for improving function, and two studies examined KRT assessments for safety and task performance. This provides very limited evidence for the effectiveness of KRT-based interventions compared to interventions not based on KRTs.

Conclusion: While KRT-based OT interventions in ABI rehabilitation are common practice, there is currently limited research evidence to support this. Further studies are warranted to strengthen the evidence base.

Keywords

Brain Injury, Meal Preparation, Rehabilitation, Kitchen, cooking

Introduction

Occupational therapy (OT) emphasises the relationship between cognition and occupation involving occupation-based, client-centred intervention (Gillen, 2015; Katz, 2005). The intervention focuses on assisting people to engage in daily life activities that they find meaningful (COT, 2013). Hence, task-based approaches using a variety of common activities of daily living (ADLs) are frequently used in clinical practice to facilitate functional rehabilitation after brain injury and stroke. Such task-based interventions and ADL retraining not only provide a holistic approach to treatment; there is also strong evidence that these improve functional independence and prevent skill deterioration after stroke (Legg et al., 2006). Task-specific training is also highly recommended in stroke and brain injury rehabilitation to access enduring motor learning associated cortical re-organisation (Harvey, 2009).

Kitchen-related tasks (KRTs) in various forms, such as preparation of snacks, meals, breakfast and hot drinks, are routinely used as instrumental ADLs in OT for patients who have acquired brain injury (ABI). KRTs have been in common practice in OT due to their high therapeutic properties, for example, their continuous demand on the person's ability to schedule, predict, and plan a series of abstract consequences of actions, with a high motor and sensory requirements to complete the task (Cerasa et al., 2017). However, although the perceived value of using such a task-based approach is well established, the evidence on the specific use of these KRTs is unclear.

A substantial number of people experience cognitive and motor impairment after ABI, which influences their participation in various occupational performance (Gillen, 2015). This is commonly manifested as having difficulty in performing basic and domestic ADLs. Various studies have established a strong correlation between decreased processing speed and executive functioning difficulty during meal planning and preparation in closed head-injured patients and patients with resected frontal lobe tumours (Godbout et al., 2005). Literature suggests performance and skills in functional cooking are related to intact cognitive abilities in delayed verbal memory, simple auditory attention and visuospatial skills, as well as overall cognitive performance, although cooking also involves significant motor ability (Yantz et al., 2010). Cognitive difficulties, especially those involving executive functions and visuospatial perceptions, are associated with an individual's ability to plan and prepare a meal after a traumatic brain injury (Neistadt, 1994a; 1992a). Similar relationships have also been established in patients who have had a stoke (Yantz et al., 2010). Strong correlations have been described between functional cooking and neuropsychological performance of attention, working memory, and verbal fluency cognitive performance such as orientation, perception, visuomotor organisation, and "thinking operations" in inpatients with stroke (Baum et al., 2008; Katz et al., 2000). Moreover, functional cooking activities have been identified as important for the individual's sense of life satisfaction (Hartman-Maeir et al., 2007) and are highly valued by patients as meaningful occupation during rehabilitation after stroke and head injury (Bigelius et al., 2010).

Hence, KRTs are used both as brief, non-standardised, performance-based instrumental ADL measures for functional assessment of impaired skills (Hartman-Maeir et al., 2009; Baum et al., 2008; Neistadt, 1992a), and as part of the assessment in preparation for discharge. These typically involve self-report or non-standardised clinical assessments. Meal preparation tasks have also been frequently used in neuropsychological research exploring cognitive functioning of the brain in relation to self-awareness, occupational identity and community integration after brain injury (Schmidt, 2015; Chevignard et al., 2008; Hartman-Maeir et al., 2007). In addition, KRTs are frequently used as treatment activities for improving specific functional performance. The use of KRTs for functional retraining has been described as an excellent opportunity for procedural skill development in people after brain injury, using learning through the implicit memory system and neuro-functional approaches through task-specific training (Trevena-Peters et al., 2018). However,

there are few standardised approaches for the implementation and evaluation of KRT-based interventions (Zhang, 2003).

Little is known about current practices and the value of using KRT interventions in the rehabilitation of adults with ABI, particularly in the acute setting. Despite the frequent use of KRTs in clinical practice for both assessment and treatment purposes in acute inpatient rehabilitation units in the United Kingdom (UK), there is a scarcity of evidence to support their clinical and cost-effectiveness in these settings. Also, there have been reports of inconsistency in the application of KRT activities, especially for clinical decision-making prior to discharge (Crenan and MacRae, 2010). There is, therefore, a need to identify the evidence for KRTs as an intervention in acute rehabilitation settings to inform and guide current clinical practice. A systematic review was conducted, with the aim to investigate the effectiveness of KRT-based OT interventions for improving clinical and functional outcomes in the rehabilitation of adults with ABI. The objective was to identify and summarise the evidence for the use of KRTs in OT, both as assessments and treatments for adults with ABI in rehabilitation settings.

Methods

A systematic review is the appropriate method to systematically search for, appraise, and synthesise research evidence, to answer a defined, focused question (Unsworth, 2017; Grant and Booth, 2009). Details of the protocol for this systematic review were registered on PROSPERO and can be accessed at www.crd.york.ac.uk/prospero/display_record.php?ID=CRD42019141898. Reporting of this systematic review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement (Moher et al., 2009). The PRISMA checklist is given in appendix 1.

The search strategy was developed based on concepts and keywords used in the Population, Intervention, Comparison, Outcomes and Study design (PICOS) framework:

- Types of participants: Adults (age 18+ years) with ABI. ABI defines a brain injury that is not hereditary, congenital, degenerative, or induced by birth trauma, but a type of brain injury that has occurred after birth, including stroke or Cerebrovascular Accident (CVA) and traumatic brain injury (TBI) or head injury (HI).
- Types of interventions: KRTs either directly facilitated or supervised by an occupational therapist, in the context of rehabilitation provision. For the purpose of this review, the term “intervention” was used to encompass both “assessments” (patient evaluations using KRTs with implications for clinical decision-making such as discharge planning) and “treatments” (KRT-based activities which are commonly delivered over a course of sessions and which aim at achieving functional gain).
- Types of comparators: Any alternative intervention(s) or usual care.
- Types of outcomes: Performance in specific task components or functional outcomes, quality of life, length of hospital stay, discharge goals or destinations, level of support required for independent living post-discharge, patient satisfaction, outcomes related to safety or other risks that might guide rehabilitation practice.
- Types of study designs: Controlled trials (including randomised and quasi-randomised controlled trials), cohort studies, case-control studies, case series and single case studies/case reports were included for review of the evidence and quality analysis.

The search strategy included search terms such as ‘meal preparation’, ‘kitchen’, ‘hot drink’, ‘stroke’ and ‘brain injuries’. The full search strategy is given in appendix 2. The authors searched relevant electronic databases and registries (from inception or from 1979, whichever was later) for peer-

reviewed scientific publications (BNI, CINAHL Plus, CDSR, DORIS, Google Scholar, MEDLINE, OT Seeker, OTDBase, PEDro, PsychBITE, PsychINFO, REHABDATA, Scopus, TRIP Pro, Web of Science Core Collection), records of ongoing studies (CENTRAL, Clinical Trials, ISRCTN registry, PROSPERO) and grey literature (Ethos, HILO, OpenGrey). Reference lists of review articles and other relevant papers were hand-searched, and researchers were contacted directly when necessary. Searches were completed from 08 to 16 July 2019. Time-restricted searches were re-run prior to the final analysis to include further relevant studies (last date searched 20 November 2019). Published English-language reports of completed studies were included in the first instance; unpublished studies were also considered if the relevant information was made available.

The two authors independently screened search results against eligibility criteria according to the PICOS. Results were de-duplicated after screening the title and abstract, and the two authors independently reviewed the remaining results in full text. Disagreements were resolved by discussion and consensus. As part of this process, a decision was made to revisit and refine the eligibility criteria, to ensure that relevant literature was included. The study setting had initially been restricted to inpatient settings where OT was provided as a part of rehabilitation on a regular basis, such as in acute hospitals or inpatient rehabilitation facilities. Due to the small number of eligible studies, this eligibility criterion was widened to include studies conducted in community settings. Additionally, the comparator criterion was widened to also include usual care. It was decided to explicitly exclude studies conducted within the context of (neuro-)psychology, where the focus was on validating standardised psychological assessments against an individual's performance of KRT, as opposed to OT rehabilitation. Lastly, the authors decided to include studies which did not report patient outcomes, but which were directly relevant to KRTs in the context of OT in rehabilitation of ABI.

A standardised data extraction form was used to independently extract specific data items for each study, including the first author and year of publication, aim(s), design and methods, study setting, intervention, comparison, description of the KRT(s), participant characteristics, outcome measures, and study findings extracted against each outcome measure. The authors used the checklist for assessing the quality of quantitative studies developed by the Alberta Heritage Foundation for Medical Research (2004) to accommodate a variety of study designs in assessing the risk of bias of individual studies. Additionally, for all controlled studies, the PEDro quality assessment tool was completed with the calculated PEDro summary score (De Morton, 2009). The hierarchy of evidence developed by the Oxford Centre for Evidence-Based Medicine (OCEBM, 2011) was used to give a description of the level of evidence for individual studies.

After considering the feasibility and appropriateness of combining quantitative data in view of statistical, clinical, and methodological heterogeneity, a decision was made to conduct a narrative synthesis of findings. Quantitative data were analysed descriptively (summary measures for each relevant outcome).

Results

Titles and abstracts of 2,227 records were screened. Of these, 2,031 records did not match the PICOS and were excluded. After de-duplication, 78 full-text articles were assessed for eligibility and 56 were excluded. Reasons for exclusion at this stage are given in the PRISMA flow diagram (figure 1). The remaining 22 articles reported 17 primary studies and were included for data extraction, assessment of bias and narrative synthesis.

The included studies were heterogeneous with respect to PICOS criteria, sample size and follow-up period. Eleven studies were conducted in inpatient settings (Cerasa et al., 2019; Eakman and Nelson,

2001; Edmans et al., 2009; Foxhall and Gurr, 2014; Liu et al., 2004; Logan et al., 2003; Patterson et al., 2017; Paul et al., 2007; Schmidt et al., 2013; Tanguay et al., 2014; Trevena-Peters et al., 2018) and six in community settings (Gasser-Wieland and Rice, 2002; McGraw-Hunter et al., 2006; Neistadt, 1992a; Ownsworth et al., 2017; Poncet et al., 2018; Robnett et al., 2016). Participant characteristics included individuals with TBI in five studies (McGraw-Hunter et al., 2006; Ownsworth et al., 2017; Patterson et al., 2017; Schmidt et al., 2013; Trevena-Peters et al., 2018), CVA in six studies (Cerasa et al., 2019; Edmans et al., 2009; Gasser-Wieland and Rice, 2002; Liu et al., 2004; Logan et al., 2003; Paul et al., 1997), and ABI from various causes in the remaining six studies. Six studies were randomised controlled trials (RCTs; Eakman and Nelson, 2001; Liu et al., 2004; Neistadt, 1992a; Ownsworth et al., 2017; Schmidt et al., 2013; Trevena-Peters et al., 2018). Other study designs included a retrospective analysis of trial data (Logan et al., 2003), cross-sectional observational studies (Patterson et al., 2017; Robnett et al., 2016; Tanguay et al., 2014), and single case reports or case series with repeated measures design (Cerasa et al., 2019; Edmans et al., 2009; Gasser-Wieland and Rice, 2002; McGraw-Hunter et al., 2006; Patterson et al., 2017; Paul et al., 1997; Poncet et al., 2018). In one study (Foxhall and Gurr, 2014), therapeutic meal preparation group sessions were observed to describe and assess the content of sessions. Sample sizes ranged from a few participants in single case reports and case series to n=309 in the retrospective analysis of trial data by Logan et al. (2003). Detailed study characteristics are presented in table 1.

With respect to the intended purpose of KRT interventions, the studies were thematically grouped to give an overview of the investigators' rationales and approaches for studies of KRTs (table 2). Fifteen studies pursued the overall aim of improving cognitive function, physical function, or task performance through KRT treatments. Of these, five studies compared KRT against non-KRT treatments or usual care, i.e. the KRT treatment constituted the aspect under investigation (Cerasa et al., 2019; Edmans et al., 2009; Logan et al., 2003; Neistadt, 1992a; Poncet et al., 2018). Eight studies examined treatments in which the aspect under investigation was delivered through a KRT, but was not inherently related to KRTs, e.g. a comparison of error-less and error-based learning in cooking (Eakman and Nelson, 2001; Gasser-Wieland and Rice, 2002; Liu et al., 2002; McGraw-Hunter et al., 2006; Ownsworth et al., 2017; Paul et al., 1997; Schmidt et al., 2013; Trevena-Peters et al., 2018). Two studies aimed to provide detailed descriptions of KRT treatments without investigation of the outcome (Foxhall and Gurr, 2014; Patterson et al., 2017). In contrast to these 15 studies, the studies by Robnett et al. (2016) and Tanguay et al. (2014) examined the use of KRTs for the purpose of assessing safety and/or capability of task performance. Additionally, several of the included studies addressed two distinct points of interest: firstly, the comparison of KRTs as occupationally embedded and meaningful activities as opposed to abstract or isolated tasks and activities (Eakman and Nelson, 2001; Gasser-Wieland and Rice, 2002; Neistadt, 1992a); and secondly, the use of virtual KRTs to substitute actual kitchen environments (Edmans et al., 2009; Tanguay et al., 2014; table 2).

Individual quality assessments of included studies are presented in appendix 3. Summary quality scores ranged from 37% to 100% with a median of 67% (percentage of the possible maximum score, higher percentages reflect better study quality). For the six RCTs, the PEDro score ranged from 6/11 to 9/11 with a median of 9/11 (higher scores reflect better study quality). The RCTs also yielded the highest level of evidence (OCEBM level 2), except for the study by Eakman and Nelson (2001), which was graded down to OCEBM level 3 due to lower quality. The remaining studies were graded at evidence levels 3, 4 and 5, based on study design and quality. The study by Foxhall and Gurr (2014) was not graded due to its purely descriptive design.

Study outcomes reflect the heterogeneity in study aims and designs. Outcome measures included standardised measures of cognitive/physical impairment and activity (incl. standardised assessments of KRTs), as well as measures which were customised specifically to the KRT and intervention or the

respective study (e.g. computerised scoring of a virtual KRT training programme). Details of outcome measures and results are presented in table 3.

KRTs as treatment

In the group of studies which compared KRT treatments against non-KRT treatments or usual care, the RCT by Neistadt (1992a) provided high-level moderate-quality evidence that an occupationally embedded KRT in patients with ABI in a community setting did not result in better improvement in the Rabideau Kitchen Evaluation-Revised than an abstract construction task; although there was a trend in favour of the KRT group. The secondary analysis of RCT data by Logan et al. (2003) provided moderate-level moderate-quality evidence that the provision of cooking therapy in inpatient rehabilitation of patients with CVA did not increase the likelihood of independence in cooking tasks. The single case reports/series by Cerasa et al. (2019), Edmans et al. (2009) and Poncet et al. (2018) yielded low-level moderate-quality evidence for their respective KRT treatments and patient groups, with mixed findings of some improvement in co-ordination and cognitive function in Cerasa et al. (2019); no improvement in hot drink making scores in Edmans et al. (2009); and statistically significant improvement in the Cooking Task in Poncet et al. (2018).

Other treatments delivered through KRTs

In the group of studies in which the aspect under investigation was delivered through a KRT but not inherently related to the KRT, the RCT by Eakman and Nelson (2001) provided moderate-level moderate-quality evidence that hands-on meal preparation training in inpatients with CVA led to better recall of the recipe than verbal training; the RCT by Liu et al. (2004) provided high-level high-quality evidence that task training (including KRTs) based on mental imagery in inpatients with CVA led to greater independence in task performance compared to 'demonstration-then-practice' training; the RCT by Ownsworth et al. (2017) yielded high-level high-quality evidence that error-based learning in task training (including KRTs) in community-dwelling patients with TBI led to improvements in the Cooking Task compared to an error-less learning approach; the RCT by Schmidt et al. (2013) provided high-level high-quality evidence that KRT training with video and verbal feedback in inpatients with TBI achieved KRT performance with fewer errors than training with verbal or experiential feedback alone; and the RCT by Trevena-Peters et al. (2018) yielded high-level high-quality evidence that ADL training (based on errorless learning and including KRTs) in inpatients with TBI and post-traumatic amnesia led to Functional Independence Measure improvements in a greater proportion of patients compared to usual care. The single case series by Gasser-Wieland and Rice (2002), McGraw-Hunter et al. (2006) and Paul (1997) yielded low-level and low- to moderate-quality evidence for their respective treatments and patient groups, with findings of improved upper limb kinematics (Gasser-Wieland and Rice, 2002), improved performance of a KRT (McGraw-Hunter et al., 2006), and improved scanning time and accuracy (Paul, 1997).

KRTs as assessments

In the group of studies that investigated the use of KRTs for the assessment of safety and/or capability of task performance, the study by Robnett et al. (2016) provided moderate-level moderate-quality evidence of moderate and statistically significant correlations between the Safe at Home Screening score, the Kohlman Evaluation of Living Skills score, and the treating occupational therapist's judgement on participants' functional independence and home safety in ABI patients in a community setting. The study by Tanguay et al. (2014) yielded low-level moderate-quality evidence that performance in a computerised breakfast task correlated poorly with performance in real-world meal preparation in inpatients with ABI.

Discussion

Seventeen primary research studies that evaluated the use of KRTs as an intervention within OT for adults with ABI were identified and their results summarised. The value of KRTs in various forms for brain injury rehabilitation has been considered within the literature with a wide range of outcome measures used to report their impacts. This systematic review provides an overview of the available literature with a description of investigators' approaches and study designs, and an appraisal of methodological quality and levels of evidence.

The review covered a heterogeneous group of studies that used KRTs as a key component of OT interventions towards a range of outcomes in people with brain injury; both in their task performance and specific motor or cognitive impairments. Results of the studies included in this review suggest diverse levels of certainty regarding the effectiveness of KRT interventions. Due to the heterogeneity in study designs, purpose and design of KRT interventions and selection of outcomes, each study included in this review should be interpreted on its own merit.

When setting out to conduct this review, the intention was to identify the evidence for using KRTs in the rehabilitation of ABI, as compared to other non-KRT based interventions. However, a number of studies were also included in the review which did not use KRTs as the actual 'active ingredient' under investigation, but which used KRTs as the activity or 'setup' with a different focus, such as the comparison between error-less and error-based learning approaches in the study by Ownsworth et al. (2017). These types of studies made up almost half (8/17) of the included studies. Although these studies did not investigate the effectiveness of KRTs in rehabilitation *per se*, these studies were considered as relevant for this review, to provide a more comprehensive overview of the currently available literature. These studies also provided evidence of the widespread use of KRTs in OT-led rehabilitation of adults with ABI.

KRTs as treatments

Most studies (15/17) focused on improving cognitive and physical functions, or task performance through KRT-based treatments. Of these, five studies compared KRTs against non-KRT treatments or usual care; however, these studies varied greatly in terms of the intended outcomes, such as restoration of cognitive deficits (Cerasa et al., 2019) and effect on constructional abilities (Neistadt, 1992a), and the use of measures in line with the intended outcomes. Most of these studies scored low in methodological qualities (one RCT). Two further studies only provided detailed descriptions of KRT activities but did not include an investigation of effectiveness (Foxhall and Gurr, 2014; Patterson et al., 2017). This provided very limited opportunity to synthesise the evidence to describe the actual effect on functional abilities, thereby contributing to limited confidence in the evidence towards the effectiveness of KRT-based treatments for improving function or task performance in patients with ABI.

In eight studies, the aspect under investigation was delivered through a form of KRT as part of the treatment, but not inherently related to the KRT. In other words, these interventions could also have been delivered through other functional tasks. Three studies explicitly proposed the use of KRTs as meaningful, occupationally embedded activities for their therapeutic value compared to other ADLs (Eakman et al., 2001; Gasser-Wieland and Rice, 2002; Neistadt, 1992a). Consistent with the literature, this supports the perception that KRTs form a major part of activity-based treatments for improving performance in instrumental or extended ADLs. As OT emphasises interventions designed to achieve functional outcomes necessary for dwelling in a given socio-cultural environment (Legg et al., 2007), KRTs are used as a key activity in treatments, aiming to improve skills for independence in preparing meals for oneself.

OT is a complex intervention and forms an established and essential element in the rehabilitation of patients with ABI to promote health, prevent disability and restore the highest possible level of independence (COT, 2013). Despite this, there have been few studies of the nature and effectiveness of activity-based interventions provided by OT practitioners and their specific impacts on patient outcomes (Powell et al., 2016). Level of dependence in meal preparation is an important measure of the success of rehabilitation and a commonly used functional outcome in brain injury rehabilitation; however, the specific impacts of KRT-based treatments remain to be established.

KRTs as standardised outcome measures

It is acknowledged that cognitive disorders and executive functioning following brain injury are best tested in ecologically valid, naturalistic settings close to real life, using a real task (Poncet et al., 2014). It has been suggested that the clinical usefulness of standardised neuropsychological tests is limited due to their lack of sensitivity to reflect the true impact of cognitive disorders on everyday life tasks (Chevignard et al., 2000; Poncet et al., 2014). In this regard, this review has demonstrated the extensive use of KRTs towards assessment of a range of cognitive, motor, and functional deficits following ABI. Several studies in this review used standardised and validated assessment tools such as the Rabideau Kitchen Evaluation-Revised (RKE-R) (Neistadt, 1992a), the Cooking Task (Chevignard et al., 2000), and the Kettle Test (Hartman-Maeir et al., 2009). These assessments use a KRT as the main task to systematically assess individuals' levels of task performance and to identify deficits. However, these measures are not very widely used and are constructed to test various aspects of KRT, such as cognitive deficits (Kettle Test), executive function (Cooking Task) and skills for meal preparation (Rabideau Kitchen Evaluation-Revised). Moreover, there are only few studies on reliability, validity and clinically important difference of these measures. Hence, the current evidence suggests that there is a lack of well-validated standardised outcome measures for KRT intervention studies that can reliably report a clinically meaningful change in the participants' ability to complete a meal preparation task.

Standardised home safety assessments

Although KRTs commonly form part of standardised assessments for home safety, the review has not identified any evidence that a standalone KRT-based assessment could predict safety of the person at home post-discharge. A variety of cognitive deficits resulting from ABI can directly affect safety for living in the community and occupational performance in a variety of tasks (Eriksson et al., 2006). Therefore, it is common practice in OT to assess for potential safety issues in function through both informal and formal assessments (Robnett et al., 2016). Only two studies were identified, where KRTs were used for this purpose in individuals with ABI. One study demonstrated the limitations in substituting actual meal preparation with a computerised KRT (Tanguay et al., 2014); another established the potential value and validity of the Safe at Home Screening, a quick assessment tool for safe living skills in patients with ABI (Robnett et al., 2016). In the Safe at Home Screening, a mock hazardous situation is set up in a kitchen setting. This could provide a standardised tool for occupational therapists to assess home safety in patients with ABI and guide discharge planning; however, no study was found that investigated its effectiveness for clinical outcomes such as reduction of adverse events post discharge. The literature also describes other in-depth standardised assessment tools for assessing safety, such as the SAFER, the Westmead Home Safety Assessment (WeHSA); the Home Falls and Accidents Screening Tool (HOME FAST); the CASPAR, the Housing Enabler, and the Kohlman Evaluation of Living Skills (KELS; Robnett et al., 2016). A general disadvantage of these tools is their lengthy assessment process.

Limitations

The main limitation of the review relates to the high level of heterogeneity of the studies, restricting the reviewers' ability to compare and pool the evidence. Many studies had small sample sizes with weaker methodologies (e.g. case reports/series) and short intervention periods with no long-term follow-up. Variations in the appraised studies must be considered when interpreting the results. Another limitation relates to heterogeneity in the original study authors' descriptions of KRT-based interventions. While some authors have given relatively detailed descriptions of their KRT interventions within articles or in referenced intervention protocols and manuals, the level of detail provided by others is rather sparse. It may be recommended that future studies make use of the TIDieR reporting guideline for complex interventions (Hoffmann et al., 2014), to provide comprehensive intervention descriptions that will allow replication by other investigators. Lastly, non-English publications were excluded, and it is possible that relevant study reports published in other languages were missed.

One of the strengths of the review was the use of a comprehensive search strategy, which included searching in OT-specific databases and grey literature. This resulted in a large number of studies considered for review. In addition, a rigorous and explicit approach was applied to identifying, appraising and synthesising this heterogeneous and complex body of literature in a concise manner.

Implications for occupational therapy

Although there have been several studies of instrumental ADL training for people who have had a stroke and are living in the community (Walker et al., 2004), there has not been a previous review of the effectiveness of KRTs specifically for rehabilitation of people with ABI. The review adds to the literature by reporting on the use and effects of OT-focused KRTs in patients with ABI. These results have several implications for practice, education, and research.

Although there is evidence for some applications of KRTs in clinical practice, the effectiveness of KRTs is not fully established for rehabilitation of specific performance components after ABI. Hence, practitioners should be cautious in applying KRTs in OT treatments and assessments with this cohort, especially for the purpose of determining discharge recommendations. On the basis of the evidence, educators and practitioners are encouraged to seek relevant evidence in broader studies about KRTs in mixed or other similar patient groups. Practitioners may consider the results column in Table 3 of this review along with the quality assessment provided in Appendix 3 for detailed practice information.

Further work is required to define the actual benefits of using KRTs as an intervention. Economic studies are also required to examine the cost-effectiveness of using kitchen-related activities for OT interventions, especially within acute rehabilitation settings. The role of KRTs in determining safety for discharge requires further investigation. Although it has been established that OT as a package of interventions is effective (Legg et al., 2007), further research is needed to better understand specific components within this, for example the effectiveness of KRT-based interventions for improving long-term functional outcomes for people with ABI. Larger sample sizes with randomised allocation to intervention will permit further analysis of the impact of the intervention.

Conclusion

This review has identified literature to demonstrate that KRTs are used in various forms as part of OT-led rehabilitation for people with ABI, both for therapeutic assessment and as treatments for improving specific impairment or occupational performance. However, heterogeneity between included studies and partly low methodological quality complicate the interpretation of findings. Judging from this body of evidence, the effectiveness of KRT-based interventions for improving

clinical and functional outcomes remains to be established. Hence, practitioners should be cautious while using KRTs as OT interventions for ABI and seek further clarification of purpose. In addition, detailed description such as a protocol for using KRT interventions should be encouraged. Further research is warranted to address limitations of previous studies and generate more definitive results.

Key findings

- Literature reflected the use of KRTs in common practice in OT for ABI rehabilitation, both for assessment and treatment.
- There is limited evidence of OT-led KRTs as an effective intervention for ABI rehabilitation due to heterogeneity of intervention design and methodical quality of available studies.

What the study has added

The study provides evidence on the continuing use of KRTs in OT interventions for brain injury rehabilitation along with other functional activities. However, the effectiveness of KRT-based interventions in restoring specific deficits remains to be established.

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Tables and figures

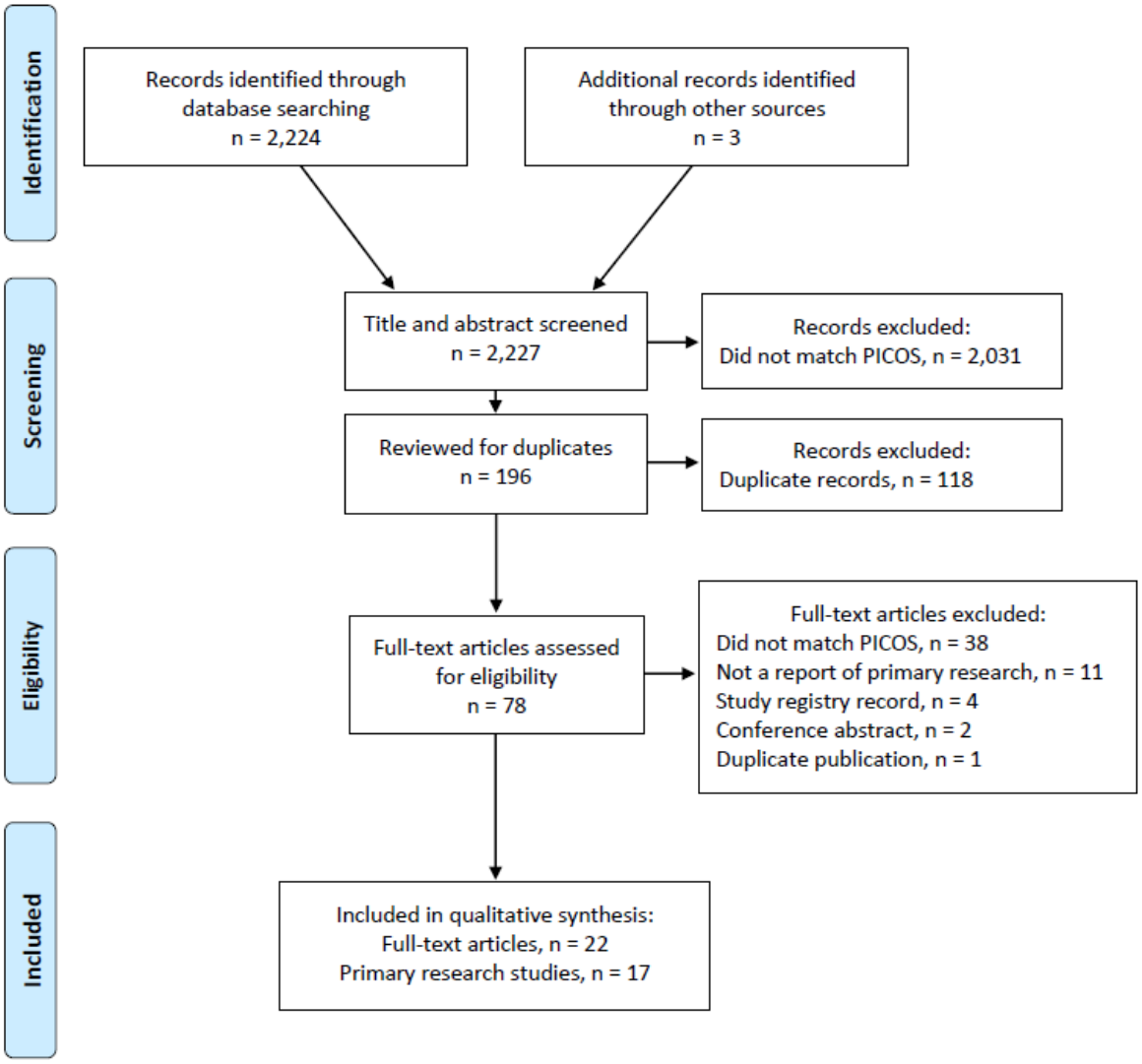

Figure 1. PRISMA flow diagram

Table 1. Study characteristics

First author, year (primary publication)	Secondary publications of the same study	Country	Setting	Study aim(s)	Study design	Participants
Cerasa 2019		Italy	Inpatients: Neuro-rehabilitation centre	To evaluate the effect of cooking training in restoring cognitive deficits	Single case report with pre-/post- assessments	N=1, CVA, male, age 68 years
Eakman 2001		United States	Inpatients: Rehabilitation centres	To compare the effect of two learning approaches (hands-on occupation *vs* verbal training) on recall of cooking instructions	Randomised controlled trial	N=30 (IG=15, CG=15), ABI, male=100%, mean age 29.6 years (SD 9.1)
Edmans 2009		United Kingdom	Inpatients: Acute stroke unit	To evaluate the effect of a non-immersive virtual reality training on real-world hot drink preparation	Single case series with within-subject alternation of intervention and control conditions	N=13, CVA, male=77%, mean age 72.8 years (SD 11.4)
Foxhall 2014		United Kingdom	Inpatients: Brain injury rehabilitation unit	To assess whether a weekly group-based OT-led 'Life Skills Group' incorporates evidence-based recommendations for executive functioning and positive social interactions	Observations by a researcher of 4 group sessions and categorisation of observed behaviours and strategies against the evidence base	N= approx. 4 per group with fluctuating attendance, ABI, mixed gender, age range 49 to 62 years
Gasser-Wieland 2002		United States	Community: Outpatient rehabilitation centre	To compare upper limb movement dynamics of an occupationally embedded condition to a nonoccupationally relevant condition in stroke survivors	Single case series with within-subject alternation of the two conditions	N=17, CVA, gender not reported, mean age 65.5 years (SD 12.4)
Liu 2004		Hong Kong	Inpatients: Rehabilitation Unit	To compare the effect of mental imagery *vs* conventional functional rehabilitation on promoting relearning after stroke	Randomised controlled trial	N=49 (IG=27, CG=22), CVA, male=51.0%, mean age 71 years (SD 6.0)
Logan 2003		United Kingdom	Inpatients: Acute hospital	To compare the effect of OT for activities of daily living (ADL) *vs* OT for leisure on therapy outcome	Secondary retrospective analysis of data from a randomised controlled trial	N=309 from two intervention groups in the original trial (ADL=156,

						Leisure=153), CVA, male=59.9%, median age 71.5 years (range 65-78)
McGraw-Hunter 2006		United States	Community: Residential rehabilitation programme	To evaluate the effect of video self-modelling plus prompting and feedback on cooking skill acquisition and skill generalisation	Single case series with repeated measures	N=4, TBI, male=75%, ages 17, 22, 27 and 39 years
Neistadt 1992a	Neistadt 1992b, 1994a, 1994b	United States	Community: Residential and outpatient rehabilitation programmes	To compare the effect of training with an adaptive functional activity *vs* a remedial perceptual skills activity on constructional ability in a food preparation task.	Randomised controlled trial	N=45 (IG=23, CG=22), ABI, male=100%, mean age 33.2 years (SD 9.1)
Ownsworth 2017		Australia	Community: Outpatient and community brain injury rehabilitation services	To compare the effect of Error-Based Learning (EBL) *vs* Error-Less Learning (ELL) on skills generalisation, self-awareness, behavioural competency, and psychosocial functioning.	Randomised controlled trial	N=54 (EBL=27, ELL=27), TBI, male=79%, mean age 38.0 years (SD 13.4)
Patterson 2017		Australia	Inpatients: Brain injury rehabilitation unit	To describe the OT groups programme at the unit, evaluate the groups using patient feedback, and provide an illustrative case example of participation in the groups programme	Cross-sectional survey and single case report	N=35 (survey), TBI, male=85.7%, mean age 38 years (SD 14.1) N=1 (single case report), TBI, male, age 28 years
Paul 1997		United States	Inpatients: Subacute rehabilitation facility	To evaluate the effect of video feedback on visual neglect	Single case series with repeated measures	N=3, CVA, male=33.3%, ages 68, 70 and 73 years
Poncet 2018		France	Community: Outpatient day programme	To evaluate the effect of therapeutic cooking on activity and participation outcomes related to meal preparation	Single case series with repeated measures	N=7, ABI, male=42.5%, mean age 38 years (SD 10.1)
Robnett 2016		United States	Community: Neurological	To conduct psychometric analyses of the 'Safe at Home Screening'	Cross-sectional observational study	N=31, ABI, male=67.7%, age range 18-64 years

			intervention day programme			
Schmidt 2013	Schmidt 2015	Australia	Inpatients: Rehabilitation service	To evaluate the effect of 3 types of feedback (video plus verbal feedback *vs* verbal feedback *vs* experiential feedback) on online awareness	Randomised controlled trial	N=54 (IG=18, CG1=18, CG2=18), TBI, male=85%, mean age 40 years (SD 13)
Tanguay 2014		Canada	Inpatients: Residential transitional living rehabilitation programme	To evaluate the generalisability of a computerised breakfast task to real cooking	Cross-sectional observational study	N=22, ABI, male=68.2%, mean age 45.5 (SD 12.4)
Trevena-Peters 2018	Mortimer 2019	Australia	Inpatients: Rehabilitation centre	To evaluate the effect of ADL retraining during post-traumatic amnesia *vs* usual care on functional independence	Randomised controlled trial	N=104 (IG=49, CG=55), TBI, male=74.0%, mean age 43 years (SD 19.4)

ABI, Acquired Brain Injury
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EBL, Error-Based Learning
ELL, Error-Less Learning
IG, Intervention Group
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PT, Physiotherapist
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	with equivalent weight) from a countertop onto a cupboard shelf, with one hand.		
Liu 2004	Participants attended 15 one-hour sessions (1/day over 3 weeks) of task training. Among different available tasks, the following kitchen activities were included: preparing a cup of tea, washing the dishes, preparing fruit, tidying the table after a meal, and frying vegetables with meat.	Task practice supported through structured mental imagery, including analysis of task sequences using computer-generated pictures and movies. Identification of own problems, picture card prompts, mental rehearsal and actual practice.	Functional retraining program through the demonstration-then-practice method. Problems encountered by patients were rectified with the help of therapists.
Logan 2003	No further detail other than "cooking" activities, which was one of 34 categories of OT treatment activities conducted with participants in either ADL or leisure group. "Cooking" was conducted with 122 of 309 participants.	The leisure group received 10 OT sessions of 30-60 minutes duration per participant, using leisure activities to achieve leisure goals. Leisure activities were defined as activities done for pleasure.	The ADL group received 10 OT sessions of 30-60 minutes duration per participant, using ADL activities to achieve ADL goals.
McGraw-Hunter 2006	Preparation of a pre-packaged food item (boxed rice meal, stovetop noodles) conducted in the participant's own kitchen (home).	Graded video self-modelling and feedback. This progressed from participants viewing a video of themselves cooking without additional feedback, to practising the task with standardised additional prompts, to customised videos that addressed the participant's unique problems through specific voiceover instructions, to providing additional typed out task analysis ("recipe") for participants to refer to.	Within-subject comparison
Neistadt 1992a	Preparation of hot beverages and light snacks according to a protocol of 6 graded levels. Levels increase in difficulty through increasing number of steps required to prepare the meal. A detailed description of the meal preparation treatment protocol is given in Neistadt (1994a, appendix B).	The functional training group received three 30-min individual treatment sessions per week for 6 weeks in addition to their regular rehabilitation programs. Functional training was guided by OTs according to the graded treatment protocol (Neistadt, 1994a, appendix B).	The perceptual skills training group received three 30-min individual treatment sessions per week for 6 weeks in addition to their regular rehabilitation programs. Treatment consisted of parquetry block training, based on the Parquetry Block Test. This involves constructing designs from 32 blocks according to model design cards.
Ownsworth 2017	Preparation of a hot meal (stir fry) in the participant's home, with supervision/support of an OT.	The EBL group received an 8-week home-based training program (weekly 90-minute sessions) in which OTs applied the EBL approach. In the first 4 of 8 training sessions, participants learnt to prepare the stir-fry. In the last 4 training sessions, OTs developed a	The ELL group received training based on the same parameters as the EBL group, but with application of the ELL approach. OTs followed manualised treatment protocols for ELL (Ownsworth et al., 2017, table 1).

		set of multiple tasks or a complex multistep activity related to participants' goals and interests for skills generalisation. Examples included performing household tasks, running errands in a shopping centre, computer skills training, and locating resources in a local library or university. OTs followed manualised treatment protocols for EBL (Ownsworth et al., 2017, table 1).	
Patterson 2017	Four different OT groups were offered in the programme, each facilitated multiple times per week. Of these, one group addressed meal preparation (breakfast group twice weekly and lunch group twice weekly). The groups not related to KRTs addressed community access, upper limb function and cognitive rehabilitation. The number of each type of group could be adjusted to reflect patient needs at the time. Groups included 3–4 participants with staff to patient ratio 1:4.	Breakfast group twice weekly and lunch group twice weekly.	Within-subject comparison (single case report)
Paul 1997	Grocery-shelf scanning task	Individual video feedback twice a week for 2 weeks (30-40 minutes per session). Video films of the participant's behaviour when performing the grocery-shelf scanning task were reviewed with an OT. The OT stopped the film when it showed neglect behaviour and discussed strategies for the participant.	Within-subject comparison
Poncet 2018	Structured OT-led cooking activity based on principles of holistic neuropsychological rehabilitation, errorless learning, problem solving and metacognitive rehabilitation. The activity targets participants' individual abilities and personal goals and can incorporate compensatory aides, accommodations, external memory compensation and strategies for controlling inappropriate social behaviours. A detailed description is given in Poncet et al. (2018, online supplement).	Therapeutic cooking was provided on one morning per week. It was part of an intensive outpatient rehabilitation programme (7 weeks, 5 days per week) including individual sessions with OT, PT, speech-language therapist and medical services, group activities, sports, and joint meals at lunchtime.	Within-subject comparison

Robnett 2016	'Safe at Home Screening': Thirteen potentially unsafe (mock) situations are set up in a kitchen setting, *e.g.* a knife sticking over the edge of a countertop, a towel placed over the toaster, *etc.* Test takers are asked to identify as many hazards as they can and then take measures to correct the problems first by following a few ordered instructions and then through their own problem solving.	'Safe at Home Screening', a brief focused home safety screening tool intended to provide succinct information about home safety awareness and capacity. The test was administered at the day programme site.	Within-subject comparison with Kohlman Evaluation of Living Skills score and with OT prediction about the client's home safety
Schmidt 2013	Meal preparation task in the kitchen of the service provider, 4 sessions with 2 to 4 days between sessions. A choice in 3 meals was provided to increase motivation and engagement: spaghetti bolognaise, ham and cheese omelette with toast, or sausages and mashed potatoes. These options were assessed to have equal levels of difficulty (similar number of steps, ingredients, and time required to prepare the meal). An OT provided appropriately timed prompts and on-the-spot feedback using the 'pause, prompt, praise' technique during the session.	Video plus verbal feedback: Structured feedback following each meal preparation session. The OT and participant individually rated independence of task completion at the end of the meal preparation task. Participants then watched their videotaped performance of the meal preparation task with the therapist. While viewing, the therapist encouraged the participant to retrospectively identify errors in task performance, observe areas of strength, and suggest compensatory strategies that could be used in future sessions. The OT and the participant then verbally discussed any discrepancies in their ratings of the independence of task performance.	Verbal feedback: The OT and the participant verbally discussed any discrepancies in their ratings of the independence of task performance. Experiential feedback: No direct feedback was provided following the meal preparation task. The participant and OT separately rated independence of task performance. Ratings were not discussed.
Tanguay 2014	Computerised meal simulation task using a touchscreen monitor. The main objective was to 'cook' five breakfast food items in a specified order and for given ideal cooking times, and to have food items 'ready' at the same time, while simultaneously setting places at a virtual table.	Computerised meal simulation task administered at the programme site.	Within-subject comparison with actual meal preparation skills as assessed by an OT or life skills counsellor (4 observed meal preparation session per participant).
Trevena-Peters 2018	Light meal preparation was one of 9 components of the ADL retraining intervention (other components included bathing, grooming, dressing, and self-feeding, *etc.*). Therapy was conducted in a specialised ward for patients with post-traumatic amnesia.	Individual ADL skills retraining during post-traumatic amnesia was provided by OTs in addition to usual care. Retraining was based on errorless and procedural learning principles and a neurofunctional approach to task-specific training. OTs provided support	Usual care (daily PT and/or speech-language therapy for swallowing and communication).

		to promote task performance and avoidance of errors. Performance of task components was graded using a hierarchy of support (physical assistance, guided movement, verbal prompting, visual cues, supervision, and independence). OTs followed an intervention manual comprising 9 modules (Trevena-Peters et al., 2018, table 1).	

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Table 2. Thematic grouping of studies according to the intended purpose of kitchen-related tasks

First author, year	Studies of KRT treatments for improving cognitive function, physical function, and/or task performance			Studies of KRTs used for the assessment of safety and/or capability of task performance	Studies of KRTs as occupationally embedded and meaningful activities, compared against abstract/isolated tasks and activities	Studies of virtual KRTs, with the aim to provide substitutes for actual kitchen environments
	Studies in which KRT interventions were compared against non-KRT interventions or usual care (*i.e.* the KRT intervention constituted the aspect under investigation)	Studies of KRT interventions, in which the aspect under investigation was delivered through a KRT, but not inherently related to the KRT (*e.g.* comparison of error-less and error-based learning in cooking)	Studies which provide detailed descriptions of KRT interventions, without investigation of effect			
Cerasa 2019	X					
Eakman 2001		X			X	
Edmans 2009	X					X
Foxhall 2014			X			
Gasser-Wieland 2002		X			X	
Liu 2004		X				
Logan 2003	X					
McGraw-Hunter 2006		X				
Neistadt 1992a	X				X	
Ownsworth 2017		X				
Patterson 2017			X			
Paul 1997		X				
Poncet 2018	X					
Robnett 2016				X		
Schmidt 2013		X				
Tanguay 2014				X		X
Trevena-Peters 2018		X				

Table 3. Outcome measures and results

First author, year	Outcome measures	Results	Comments
Cerasa 2019	Cerebellar motor deficit scale Kinematic analysis of upper limbs Executive function (TOL, WCST) Attention/working memory (VS, TMT, SDMT, Digit Span) Praxis assessment (CD, CDL, ideomotor praxia) Verbal fluency assessment (COWAT) Mood assessment (HAMA, HAMD)	Cerebellar motor deficit scale improved from 8 to 5 Kinematic analysis of upper limbs minimally improved WCST and SDMT changed from pathological to normal range All other neuropsychological tests were in the normal range at baseline and showed a tendency to improve after the intervention	
Eakman 2001	Recall of the steps involved in making meatballs in their proper order (possible total score of 38 points)	Mean recall score in IG was 11.8 and in CG 2.3	Standard deviations not reported; reported as statistically significant difference by one-tailed Mann-Whitney U Test, where a two-tailed test would be expected.
Edmans 2009	Real-world hot drink-making score Virtual hot drink-making score Barthel ADL score	Median improvement in real-world hot drink-making score during intervention phase was 0.60, and during control phase was 9.78. Median improvement in virtual hot drink-making score during intervention phase was 7.90, and during control phase was 4.77 Median Barthel ADL score was 7.45 (IQR 4-10) at baseline and 10.85 (IQR 6.5-10) at study end	Range not reported for improvements in hot drink-making scores No statistically significant difference in hot drink-making scores by Wilcoxon paired test (alpha=0.05) Statistically significant improvement in Barthel ADL score by Wilcoxon paired test ($p<0.01$)
Foxhall 2014	n/a	The content of the group sessions included elements of repeated practice and errorless learning and provided patients with opportunities for social interaction. Some areas for improvement in the facilitation of groups were noted, such as the gradual removal of support and cues and facilitation of peer interaction.	
Gasser-Wieland 2002	Movement time (time taken to place the 3 objects - shorter time indicates more efficient movement)	Movement time in occupationally embedded (OE) task was 7.09 sec (SD 1.97), and in non-occupationally embedded (NOE) task it was 8.13 sec (SD 2.34)	Outcomes measured with an electronic goniometer OE conditions had statistically significant shorter movement time and fewer movement

	Displacement (sum of angular positions throughout the task - smaller displacement indicates greater efficiency of movement) Movement units (number of times acceleration and deceleration occur in sequence, fewer movement units represents more efficient movement) Peak velocity	Displacement in OE task was 346.18 degrees (SD 86.37), and in NOE task it was 372.75 degrees (SD 86.77) Movement units in OE task were 16.25 (SD 5.40), and in NOE task they were 20.50 (SD 10.57) Peak velocity in OE task was 112.07 degrees/sec (SD 41.60), and in NOE task it was 107.23 degrees/sec (SD 42.56)	units by repeated measures ANOVA (alpha=0.05) There were no statistically significant differences between OE and NOE in the remaining variables
Liu 2004	Competence in performing 5 new tasks at the end of the intervention period (score 1=total assistance to 7=complete independence) Competence in performing the training tasks at 1-month follow-up Colour Trails Test Fugl-Meyer Assessment	Mean competence score for new task performance in the IG was 5.1 (SD 1.3), and in the CG it was 3.8 (SD 0.9) Mean competence score for trained task performance in the IG was 5.8 (SD 1.01), and in the CG it was 3.9 (SD 0.9) Colour Trails Test and Fugl-Meyer Assessment data not reported	Competence scores showed statistically significant improvements in IG over CG by repeated measures ANOVA and ANCOVA (alpha=0.05) There was not statistically significant difference in Colour Trails Test and Fugl-Meyer Assessment by repeated measures MANCOVA
Logan 2003	Extended Activities of Daily Living Scale (EADL, independence in the cooking-related item "Do you make yourself a hot snack?") Nottingham Leisure Questionnaire (NLQ, independence in the cooking-related item "Cooking for pleasure")	In the ADL group 28/153 participants received cooking therapy, and in the leisure group 94/156 For the EADL item, 73/156 in the ADL group were independent *vs* 65/153 in the leisure group (RR 1.20, 95%CI 0.92-1.57, p=0.16) For the NLQ item, 36/156 in the ADL group were independent *vs* 38/153 in the leisure group (RR 0.95, 95%CI 0.53 to 1.70, p=0.84).	The hypothesis was that greater proportion of participants receiving cooking therapy should be noticeable in the proportion who are independent on these cooking-related items at 6 months follow-up
McGraw-Hunter 2006	Percentage of correct steps in preparing the food item (out of 25 steps)	Improvement from 60% to 100% correct steps in all 4 participants at the first level of the graded video feedback (*i.e.* watching oneself cook on video, without customised feedback)	
Neistadt 1992a	Rabideau Kitchen Evaluation-Revised (RKE-R) Wechsler Adult Intelligence Scale – Revised (WAIS-R) Block Design subtest Parquetry Block Test	RKE-R mean change score in IG was -7.91 (SE 2.87), and in CG it was -2.68 (SE 1.93) WAIS-R Block Design subtest change score in IG was 0.74 (SE 0.29), and in CG it was 0.41 (SE 0.26)	RKE-R consists of evaluating sandwich preparation with 2 fillings and hot instant drink preparation, with 40 steps rated between independent and unable (score 0=independent, 120=completely unable)

		Parquetry Block Test change score in IG was -0.09 (SE 0.33), and in CG it was -0.29 (SE 0.31)	No statistically significant difference in improvement in RKE-R by ANOVA (alpha 0.05) Statistically significant improvement in Parquetry Block Test (ANOVA) in favour of CG
Ownsworth 2017	Total number of errors in the Cooking Task (primary outcome) Zoo Map Test Awareness Questionnaire (AQ) Patient Competency Rating Scale (PCRS) Sydney Psychosocial Reintegration Scale (SPRS) Care and Needs Scale (CANS) Depression Anxiety and Stress Scale (DASS-21)	Mean number of errors on the Cooking Task in EBL group was 36.25 (SE 1.87), and in the ELL group it was 42.57 (SE 1.87) No statistically significant differences in Zoo Map Test, SPRS, CANS and DASS-21 Statistically significant differences in favour of EBL in AQ and PCRS	The Cooking Task assesses executive function in ecological situations in an OT kitchen. Subjects must make a chocolate cake with a recipe and an omelette. The Cooking Task measures the success of the activity, the execution time, and the number of errors made. Statistically significant difference in Cooking Task by ANCOVA (alpha 0.05) with adjustment for baseline and education
Patterson 2017	Survey: Specifically developed 7-item questionnaire with Likert responses to elicit patients' experiences of key features of the groups Single Case report: Canadian Occupational Performance Measure (COPM) ratings (1=lowers, 10=highest)	Survey: Responses show 86.2%-100% agreement across items that the meal preparation group was perceived as useful, enjoyable, providing opportunity to practice, specific to individual needs, included provision of feedback and discussion of goals, and prided an enjoyable opportunity to work with others Single case report: COPM pre-post self-ratings (independently plan and prepare a meal) were importance 10-10, performance 8-9, and satisfaction 10-10 Pre-post therapist-rated performance was 7-8	
Paul 1997	Scanning time and scanning accuracy in the grocery-shelf scanning task	Mean scanning time was 489 (SD 48.3) at baseline and 451 (SD 45.5) at follow-up Scanning accuracy was 68.3% (SD 3.8) at baseline and 72.5% (SD 6.6) at follow-up	No statistical tests reported
Poncet 2018	Number of errors in the Cooking Task Instrumental Activities of Daily Living (IADL) Profile Assessment of Life Habits	Detailed descriptive results are presented for each of the 7 single cases, and the reader is referred to tables 3 and 4 in Poncet et al. (2018)	

	Berg balance Scale 6-Minute-Walk-Test Walking Speed during 10-Meter Walk Box and Blocks Test Montgomery Asberg Depression Rating Scale Hamilton Depression Rating Scale Evaluation Test of Attention Auditory 15-Word Learning Test	In summary, improvement between baseline and follow-up was seen for number of errors in the Cooking Task for 6/7 participants IADL Profile improved for 6/7 participants Life Habits scores improved for 4/7 participants	
Robnett 2016	Safe at Home Screening (SAH) Kohlman Evaluation of Living Skills (KELS) Treating OT's expert opinion of participants' functional independence and home safety Participants' self-scoring of their perceived SAH performance (before and after the SAH)	SAH and KELS scores were moderately correlated (Spearman's rho -0.53, p=0.002) OT's assessments were moderately correlated and mostly statistically significant: "Assistance needed" *vs* KELS (rho 0.317, p=0.161) and *vs* SAH (rho 0.629, p=0.002), "Home safety level" *vs* KELS (rho -0.510, p=0.018) and SAH (rho 0.583, p=0.004) Participants' self-scoring was not significantly correlated with SAH scores	
Schmidt 2013	Error count from video-recorded meal preparation activities (primary outcome) AQ DASS-21 Self-Perception in Rehabilitation Questionnaire (SPIRQ)	In the group with video plus verbal feedback, mean reduction in error count was 28.2 (95%CI 20.9-35.6), in the group with verbal feedback it was 7.9 (95%CI -2.2 to 18.1), and in the group with experiential feedback it was 18.2 (95%CI 11.8 to 24.5) In the group with video plus verbal feedback, mean improvement in AQ was 7.1 (95%CI 3.1 to 11.2), in the group with verbal feedback it was 1.6 (95%CI -1.6 to 4.7), and in the group with experiential feedback it was -0.2 (95%CI -3.3 to 2.9)	Reduction in error and improvement in AQ were largest in the group with video and verbal feedback and were statistically significant in between-group comparison by binomial regression (p<0.001) and ANOVA DASS-21 and SPIRQ did not show any statistically significant differences between groups
Tanguay 2014	Breakfast Task computerised assessment (*incl.* timing of total task and subtasks, sequencing, number of table settings and food checks) Real-world dinner preparation performance assessed by the clinical team and using a	Breakfast Task overall score was not significantly correlated with real-world meal preparation (rho=-0.075, p=0.78) Self-reported meal preparation abilities (RADLS) were significantly correlated with	

	customised score Rehabilitation Activities of Daily Living Survey (RADLS) including one item "Meals"	both real-world meal preparation (rho=0.536, p=0.03) and Breakfast Task scores (rho=-0.594, p=0.01) Real-world meal preparation and self-reported meal preparation abilities (RADLS) were not significantly correlated with the Breakfast Task overall score (rho=-0.075, p=0.78)	
Trevena-Peters 2018	Functional Independence Measure (FIM, primary outcome) Westmead Post-Traumatic Amnesia (PTA) Scale Rehabilitation inpatient length of stay Agitated Behaviour Scale (ABS) Community Integration Questionnaire (CIQ)	At emergence from PTA and at discharge from inpatient rehabilitation, the number of participants with a reliable change in FIM score in IG was 87.8%, and in CG it was 60.0% Mean PTA duration in IG was 44.31 days (SD 33.56) and in CG it was 52.02 days (SD 74.4) Mean length of stay was 62.26 days (SD 43.86) in IG, and in CG it was 77.55 days (SD 91.16) Mean ABS score in IG was 17.25 (SD2.99), and in CG it was 18.74 (SD 5.17) Mean CIQ score in IG was 15.07 (SD 3.96), and in CG it was 14.38 (SD4.15)	Statistically significant between-group difference in FIM score in favour of IG by Chi-squared test (p=0.001) and in a random effects regression model

ABI, Acquired Brain Injury
ABS, Agitated Behaviour Scale
ADL, Activities of Daily Living
AQ, Awareness Questionnaire
CANS, Care and Needs Scale
CD, Freehand Copying of drawings
CDL, Copying drawings with Landmarks
CG, Control Group
CIQ, Community Integration Questionnaire
COWAT, Controlled Oral Word Association Test
CVA, Cardiovascular Accident
DASS-21, Depression Anxiety and Stress Scale
EADL, Extended Activities of Daily Living Scale
EBL, Error-Based Learning
ELL, Error-Less Learning
FIM, Functional Independence Measure
HAMA, Hamilton Anxiety Rating Scale

HAMD, Hamilton Depression Rating Test
IADL Profile, Instrumental Activities of Daily Living Profile
IG, Intervention Group
KELS, Kohlman Evaluation of Living Skills
NLQ, Nottingham Leisure Questionnaire
NOE, non-occupationally embedded
OE, occupationally embedded
OT, Occupational Therapist
PCRS, Patient Competency Rating Scale
PT, Physiotherapist
RADLS, Rehabilitation Activities of Daily Living Survey
RKE-R, Rabideau Kitchen Evaluation-Revised
SAH, Safe at Home Screening
SDMT, Symbol Digit Modalities Test
SPIRQ, Self-Perception in Rehabilitation Questionnaire
SPRS, Sydney Psychosocial Reintegration Scale
TBI, Traumatic Brain Injury
TMT, Trial Making Test
TOL, Tower of London.
VS, Visual Research
WAIS-R, Wechsler Adult Intelligence Scale – Revised
WCST, Wisconsin Card Sorting Test

Appendix 1: PRISMA checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	p.3
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	p.3
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	pp.4-5
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	Methods, p.5
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	p.5
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	p.5
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	p.5
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	app.2
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	p.6
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	p.6
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	p.6
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	p.6
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	p.6
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	n/a

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	p.6
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	n/a
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	p.6, fig.1
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	table 1
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	p.7, app.3
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	table 3
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	n/a
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	n/a
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	n/a
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	pp.8-10
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	pp.10-11
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	p.11
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	p.1

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

For more information, visit: **www.prisma-statement.org**.

Appendix 2. Search strategy: MEDLINE (EBSCOhost)

#	Query	Limiters/Expanders	Last Run Via	Results
S20	S18 AND S19	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - MEDLINE	Display
S19	S7 OR S8 OR S9 OR S10 OR S11 OR S12 OR S13 OR S14 OR S15 OR S16 OR S17	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - MEDLINE	Display
S18	S1 OR S2 OR S3 OR S4 OR S5 OR S6	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - MEDLINE	Display
S17	(MH "Lunch")	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - MEDLINE	Display
S16	(MH "Snacks")	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - MEDLINE	Display
S15	"hot drink"	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - MEDLINE	Display
S14	(MH "Cooking and Eating Utensils")	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - MEDLINE	Display
S13	(MH "Cooking+")	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - MEDLINE	Display
S12	(MH "Coffee")	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - MEDLINE	Display
S11	(MH "Tea+")	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - MEDLINE	Display
S10	"meal preparation"	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - MEDLINE	Display
S9	(MH "Breakfast")	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - MEDLINE	Display
S8	(MH "Meals+")	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - MEDLINE	Display
S7	"kitchen"	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - MEDLINE	Display
S6	(MH "Cerebrovascular Trauma+")	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - MEDLINE	Display
S5	(MH "Hemiplegia")	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - MEDLINE	Display
S4	(MH "Craniocerebral Trauma+")	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - MEDLINE	Display
S3	(MH "Brain Injuries+")	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - MEDLINE	Display

S2	(MH "Stroke Rehabilitation")	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - MEDLINE	Display
S1	(MH "Stroke+")	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - MEDLINE	Display

Appendix 3. Quality assessment of included studies

Table A3. Quality assessment of included studies (Alberta Heritage Foundation for Medical Research, 2004)

First author, year	Question / objective sufficiently described?	Study design evident and appropriate?	Method of subject/comparison group selection *or* source of information/input variable described and appropriate?	Subject (and comparison group, if applicable) characteristics sufficiently described?	If interventional and random allocation was possible, was it described?	If interventional and blinding of investigators was possible, was it reported?	If interventional and blinding of subjects was possible, was it reported?
Cerasa 2019	Yes	Yes	Partial	Partial	n/a	Yes	No
Eakman 2001	Yes	Yes	Yes	No	Partial	Partial	No
Edmans 2009	Yes	Partial	Partial	Yes	n/a	Yes	No
Foxhall 2014	Yes	Partial	Yes	Partial	n/a	n/a	n/a
Gasser-Wieland 2002	Yes	Yes	Partial	Partial	Yes	No	No
Liu 2004	Yes	Yes	Yes	Yes	Yes	Yes	No
Logan 2003	Yes	Partial	Partial	Yes	Yes	Yes	No
McGraw-Hunter 2006	Yes	Yes	Partial	Partial	n/a	No	No
Neistadt 1992a	Yes	Yes	Yes	Partial	Yes	Yes	No
Ownsworth 2017	Yes	Yes	Yes	Yes	Yes	Yes	No
Patterson 2017	Yes	Partial	Partial	Partial	n/a	n/a	n/a
Paul 1997	Yes	Partial	No	No	n/a	No	No
Poncet 2018	Yes	Yes	Yes	Yes	n/a	Partial	No
Robnett 2016	Yes	Yes	Yes	Partial	n/a	No	No
Schmidt 2013	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Tanguay 2014	Yes	Partial	Partial	Partial	n/a	No	No
Trevena-Peters 2018	Yes	Yes	Yes	Yes	Yes	Yes	No

Table A3. (continued) Quality assessment of included studies (Alberta Heritage Foundation for Medical Research, 2004)

First author, year	Outcome and (if applicable) exposure measure(s) well defined and robust to measurement / misclassification bias? Means of assessment reported?	Sample size appropriate? (based on the method of the study)	Analytic methods described / justified and appropriate?	Some estimate of variance is reported for the main results?	Controlled for confounding?	Results reported in sufficient detail?	Conclusions supported by the results?	Summary score*	PEDro score^	Level of evidence~
Cerasa 2019	Yes	n/a	Yes	n/a	No	Yes	Partial	60%		5
Eakman 2001	Partial	Partial	Yes	No	No	No	Partial	46%	6/11	3
Edmans 2009	Yes	No	Partial	Partial	Yes	Yes	Yes	67%		4
Foxhall 2014	n/a	Partial	Partial	Partial	n/a	Partial	Yes	52%		n/a[#]
Gasser-Wieland 2002	Yes	Partial	Yes	Yes	No	Yes	Yes	68%		4
Liu 2004	Partial	Partial	Partial	Yes	No	Yes	Partial	71%	9/11	2
Logan 2003	Yes	Partial	Partial	Yes	No	Yes	Partial	68%		3
McGraw-Hunter 2006	Partial	Partial	Partial	No	No	Partial	Yes	44%		5
Neistadt 1992a	Yes	Partial	Yes	Yes	Yes	Partial	Yes	82%	7/11	2
Ownsworth 2017	Yes	No	Yes	Yes	Yes	Yes	Yes	86%	9/11	2
Patterson 2017	Partial	No	Yes	No	No	Yes	Yes	48%		5
Paul 1997	Partial	Partial	Partial	Partial	No	Partial	Yes	37%		5
Poncet 2018	Yes	Yes	Yes	Yes	No	Yes	Yes	78%		4
Robnett 2016	Yes	Partial	Yes	Yes	No	Partial	Yes	63%		3

Schmidt 2013	Yes	Yes	Yes	Yes	Yes	Yes	Yes	100%	9/11	2
Tanguay 2014	Partial	No	Partial	Partial	No	Partial	Yes	41%		4
Trevena-Peters 2018	Yes	Yes	Yes	Yes	Yes	Yes	Yes	93%	9/11	2

*Summary score expressed as the percentage of the possible maximum score, taking into account criteria which are not applicable
^PEDro score only applicable for randomised controlled trials (RCTs)
~Levels of evidence according to Oxford Centre for Evidence-Based Medicine (OCEBM; level 1 = highest level evidence, level 5 = lowest level evidence)
#Not applicable due to descriptive study aim